Acid Rain and Transported Air Pollutants

Implications for Public Policy

SUMMARY

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D. C. 20510

J952-25

Office of Technology Assessment

Congressional Board of the 98th Congress

MORRIS K. UDALL, *Arizona, Chairman*

TED STEVENS, *Alaska, Vice Chairman*

Senate

ORRIN G. HATCH
Utah

CHARLES McC. MATHIAS, JR.
Maryland

EDWARD M. KENNEDY
Massachusetts

ERNEST F. HOLLINGS
South Carolina

CLAIBORNE PELL
Rhode Island

House

GEORGE E. BROWN, JR.
California

JOHN D. DINGELL
Michigan

LARRY WINN, JR.
Kansas

CLARENCE E. MILLER
Ohio

COOPER EVANS
Iowa

JOHN H. GIBBONS
(Nonvoting)

Advisory Council

CHARLES N. KIMBALL, *Chairman*
Midwest Research Institute

EARL BEISTLINE
University of Alaska

CHARLES A. BOWSHER
General Accounting Office

CLAIRE T. DEDRICK
California Land Commission

JAMES C. FLETCHER
University of Pittsburgh

S. DAVID FREEMAN
Tennessee Valley Authority

GILBERT GUDE
Library of Congress

CARL N. HODGES
University of Arizona

RACHEL McCULLOCH
University of Wisconsin

WILLIAM J. PERRY
Hambrecht & Quist

DAVID S. POTTER
General Motors Corp.

LEWIS THOMAS
Memorial Sloan-Kettering Cancer Center

Director

JOHN H. GIBBONS

The Technology Assessment Board approves the release of this report. The views expressed in this report are not necessarily those of the Board, OTA Advisory Council, or of individual members thereof.

Foreword

Transported air pollutants have been the topic of much debate during the Clean Air Act deliberations of the 97th and 98th Congresses. The current controversy over acid rain—the most publicized example of transported pollutants—focuses on the risks to our environment and ourselves versus the costs of cleanup. Since 1980, the committees responsible for reauthorizing the Clean Air Act—the House Committee on Energy and Commerce and the Senate Committee on Environment and Public Works—have called on OTA many times for information about the movements, fate, and effects of airborne pollutants, the risks that these transported air pollutants pose to sensitive resources, and the likely costs of various proposals to control them. Over the course of the debate, OTA has provided extensive testimony and staff memoranda to the requesting committees, and published a two-volume technical analysis, *The Regional Implications of Transported Air Pollutants*, in July 1982. This report synthesizes OTA's technical analyses of acid rain and other transported pollutants, and presents policy alternatives for congressional consideration.

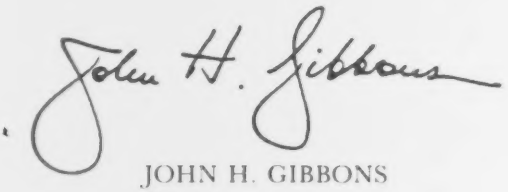
OTA's work over the last several years has enabled us to forecast with reasonable accuracy the cost of controlling pollutant emissions, and, for each of the many pending legislative proposals, who will pay those costs. We also know a great deal about the transport, fate, and effects of transported air pollutants—vastly more than was known several years ago when Congress last considered the Clean Air Act. Still, it is not yet possible to accurately evaluate the damages wrought by the pollutants or the benefits to be gained by reducing emissions, though we can say that both the risks of harm and the costs of control are substantial.

The issue of transported pollutants poses a special problem for policymakers: assuring regional equity while balancing concerns for economic well-being with concerns for natural and human resources across large regions of the Nation. Scientific uncertainties surrounding many aspects of the problem complicate the decision of whether, or when, to control transported air pollutants. Additional complexities arise from our inability to treat costs, damages, and benefits in a uniform, quantitative way. Moreover, in OTA's judgment, even substantial additional scientific research is unlikely to provide significant, near-term policy guidance, or resolve value conflicts.

How, then, can Congress address *current damage*, consider *potential harm* to recipients of transported air pollutants, yet not enforce an *unnecessarily high cost* on those who would be required to reduce pollutant emissions? OTA's analysis cannot provide an unambiguous answer to this dilemma. It does, however, lay out some carefully weighed estimates of costs, some carefully reasoned conclusions about the nature and extent of downwind

damages and risks, and several policy options that merit consideration. We hope that this information will help to narrow the issues of contention for this important environmental concern.

OTA is grateful for the assistance of the advisory panel, contractors, and the over 200 reviewers who provided advice and information throughout the course of this assessment.



JOHN H. GIBBONS
Director

Transported Air Pollutants Advisory Panel

Norton Nelson, *Chairman*
New York University Medical Center

Thomas H. Brand
Edison Electric Institute

Robert Wilbur Brocksen
Electric Power Research Institute

Jack George Calvert
National Center for Atmospheric Research

David Hawkins
National Resources Defense Council, Inc.

Edward A. Helme
National Governors' Association

Richard L. Kerch
Consolidation Coal

Gene E. Likens
Cornell University

Anne LaBastille
Adirondack Park Agency

Donald H. Pack
Private Consultant

Carl Shy
University of North Carolina

George H. Tomlinson, II
Domtar, Inc.

Principal Contractors

Brookhaven National Laboratory
Kathleen Cole, Duane Chapman, Clifford,Rossi
Energy & Resource Consultants
Environmental Law Institute
Barbara J. Finalyson-Pitts, James N. Pitts, Jr.
Brand L. Niemann
Oak Ridge National Laboratory
E. H. Pechan & Associates
Perry J. Samson
Jack Shannon
The Institute of Ecology

Additional Contributors

A. S. L. & Associates
Sanford Berg
Daniel Bromley
Thomas Crocker
Energy & Environmental Analysis, Inc.
Yacov Haimes
Perry Hagenstein
David Harrison
Walter Heck
IR & T Corp.
Steven Olson
James Reagan
Larry Salathe
John P. Skelly
SRI International
TRC Environmental Consultants
Michael P. Walsh

OTA Project Staff—Transported Air Pollutants Assessment

John Andelin, *Assistant Director, OTA*
Science, Information, and Natural Resources Division

Robert W. Niblock, *Oceans and Environment Program Manager*

Robert M. Friedman, *Project Director*

Rosina M. Bierbaum, *Assistant Project Director*

Patricia A. Catherwood, *Research Analyst*

Stuart C. Diamond,* *Editor/Writer*

George C. Hoberg, Jr.,* *Policy Analyst*

Valerie Ann Lee, *Policy Analyst*

Contributing Staff

Linda Garcia Iris Goodman Nancy Greenebaum Jennifer N. Marsh

Administrative Staff

Kathleen A. Beil Jacquelynne R. Mulder Kay Senn

*OTA consultants.

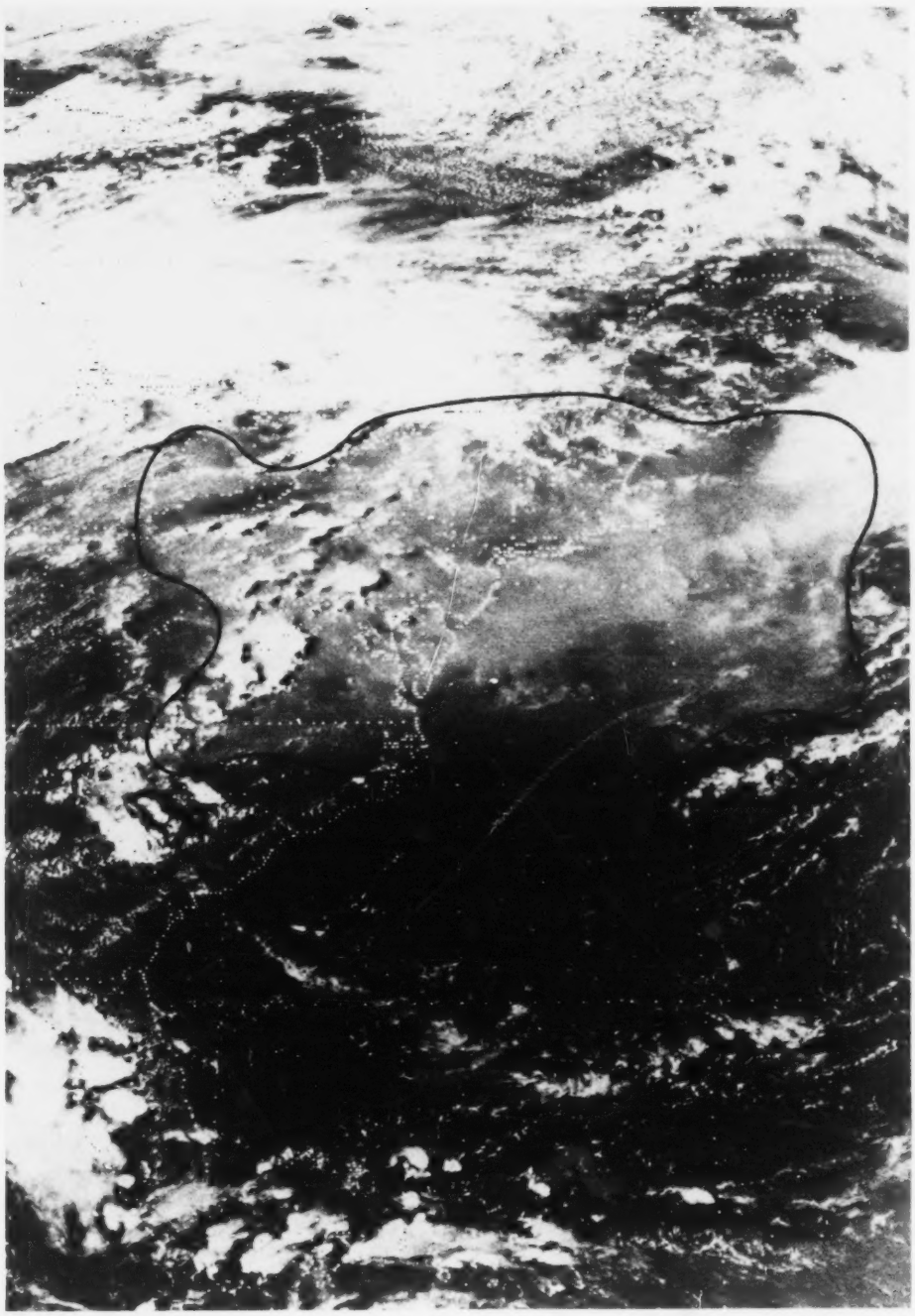


Photo credit: MESOMET, Inc.

A hazy, polluted air mass is outlined on this July 1978 enhanced satellite photo. High levels of airborne sulfate and ozone, along with low visibility, persisted for about a week over much of the Eastern United States and Canada. The polluted air mass extends far offshore—at least 500 miles from manmade emissions sources—visible evidence of long-distance transport of air pollution.

Acid Rain and Transported Air Pollutants

Until recently, air pollution was considered a local problem. Now it is known that winds can carry air pollutants hundreds of miles from their points of origin. These *transported* air pollutants can damage aquatic ecosystems, crops, and manmade materials, and pose risks to forests and even to human health. Throughout this report we discuss three of these pollutants: acid deposition (commonly called acid rain), atmospheric ozone, and airborne fine particles.

The Clean Air Act—the major piece of Federal legislation governing air quality in the United States—addresses local air pollution problems but does not directly apply to pollutants that travel many miles from their sources. However, reports of natural resource damage in this country, Canada, Scandinavia, and West Germany have made transported air pollutants—particularly acid rain—a focus of scientific and political controversy. Many individuals and groups, pointing to the risk of irreversible damage to resources, are calling for more stringent Federal pollution controls. Others, emphasizing scientific uncertainties about transported air pollutants and drawing different conclusions about how to balance risks against costs, contend that further pollution controls are premature, may waste money, and would impose unreasonable burdens on industry and the public.

OTA's analysis of acid deposition and other transported air pollutants concludes that these substances pose substantial risks to American resources. Thousands of lakes and tens of thousands of stream miles in the Eastern United States and Canada are vulnerable to the effects of acid deposition. Some of these have already been harmed. Elevated levels of atmospheric ozone have reduced crop yields on American farms by hundreds of millions of bushels each year. Acid deposition may be adversely affecting a significant fraction of Eastern U.S. forests; it, along with such other stresses as ozone and natural factors such as drought, may account for declining forest productivity observed in parts of the East. Both sulfur oxides and ozone can damage a wide range of manmade materials. Airborne fine particles such as sulfate reduce visibility and have been linked to increased human mortality in regions with elevated levels of air pollution.

The costs of reducing pollutant emissions are likewise substantial. Most current legislative proposals to control acid deposition would cost about $3 billion to $6 billion per year. Adding these new emissions control proposals to our Nation's current environmental laws would increase the total costs of environmental regulation by about 5 to 10 percent. Average electricity costs would rise by several percent—as high as 10 to 15 percent in a few Midwestern States under the most stringent proposals. Additional emissions controls could also have important indirect effects, such as job dislocations among coal miners and financial burdens on some utilities and electricity-intensive industries.

Any program to reduce emissions significantly would require about 7 to 10 years to implement. If *no* further action is taken to control emissions, 30 to 45 years will elapse before most existing pollution sources are retired and replaced with facilities more stringently regulated by the Clean Air Act. **The effective time frame of most proposals to control acid deposition, therefore, is the intervening period of about 20 to 40 years—long enough to be significant to natural ecosystems.**

If all the *risks* posed by transported air pollutants were realized over this time period, resulting resource damage would outweigh control costs. The risks discussed throughout this report, however, are *potential* consequences, not necessarily the consequences that will, in fact, occur.

One of the most difficult questions facing Congress, therefore, is whether to act *now* to control acid deposition or *wait* for results from ongoing multimillion-dollar research programs. Both involve risks. *Delaying action* for 5 or 10 years will allow emissions to remain high for at least a decade or two, with the risk of further ecological damage. But predicting the magnitude and geographic extent of additional resource damage while waiting is not possible. *Acting now* involves the risk that the control program will be less cost effective or efficient than one designed 5 or 10 years from now. Significant advances in scientific understanding over this time period, however, are by no means assured.

The distributional aspects of transported air pollutants further complicate the congressional dilemma. Because these pollutants cross State and even international boundaries, they can harm regions far downwind of those benefiting from the activities that produce pollution. Moreover, different economic sectors bear the risks of waiting or acting now to control.

The policy decision to control or not to control transported air pollutants, therefore, must be based on **the risks of resource damage, the risks of unwarranted control expenditures, and the distribution of these risks among different groups and regions of the country.** This study describes the tradeoffs implicit in this choice by characterizing the *extent* of the risks, their *regional distribution,* and the *economic sectors* that bear them. It concludes with a list of policy options available to Congress for addressing transported air pollutants.

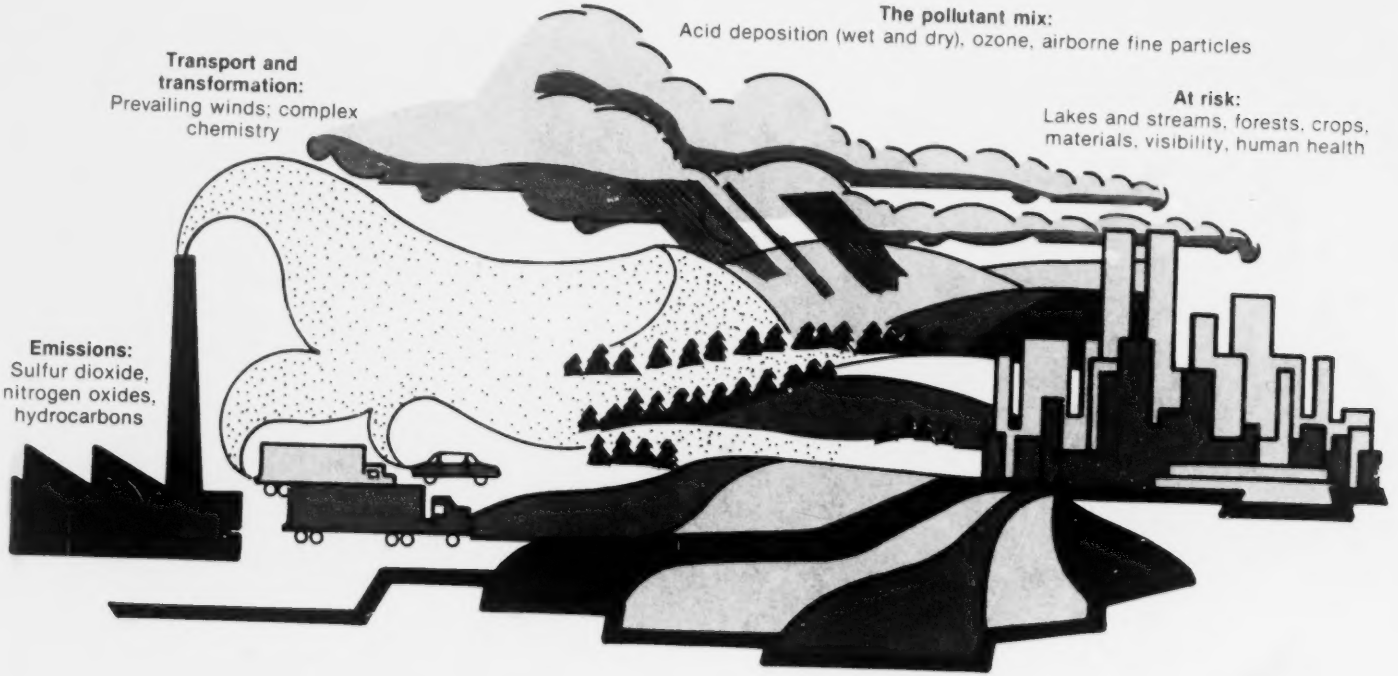
THE POLLUTANTS OF CONCERN

The transported air pollutants considered in this study result from the emission of three *primary* pollutants: sulfur dioxide, nitrogen oxides, and hydrocarbons. As these pollutants are carried away from their sources, they can be transformed through complex chemical processes into *secondary* pollutants: ozone and airborne fine particles such as sulfate and nitrate. Acid deposition results when sulfur and nitrogen oxides and their transformation products return from the atmosphere to the Earth's surface. Elevated levels of ozone are produced through the chemical interaction of nitrogen oxides and hydrocarbons (see fig. 1). Numerous chemical reactions —not all of which are completely understood—and prevailing weather patterns affect the overall distribution of acid deposition and ozone concentrations.

99-414 O - 84 - 2 : QL 3

Figure 1.—Transported Air Pollutants: Emissions to Effects

The transported pollutants considered in this study result from emissions of three pollutants: sulfur dioxide, nitrogen oxides, and hydrocarbons. As these pollutants are carried away from their sources, they form a complex "pollutant mix" leading to acid deposition, ozone, and airborne fine particles. These transported air pollutants pose risks to surface waters, forests, crops, materials, visibility, and human health.


The pollutant mix:
Acid deposition (wet and dry), ozone, airborne fine particles
Transport and transformation:
Prevailing winds; complex chemistry
At risk:
Lakes and streams, forests, crops, materials, visibility, human health
Emissions:
Sulfur dioxide, nitrogen oxides, hydrocarbons

Current levels of precipitation acidity and ozone concentrations are shown in figures 2 and 3, respectively. Peak levels of acid deposition—as measured by precipitation acidity, or pH*—center around Ohio, West Virginia, and western Pennsylvania. High levels of acid deposition are found throughout the United States and southeastern Canada. Peak values for ozone are found further south than for acid deposition, centering around the Carolinas. A band of elevated ozone concentrations extends from the mid-Great Plains States to the east coast.

During 1980 some 27 million tons of sulfur dioxide and 21 million tons of nitrogen oxides were emitted in the United States. Figure 4 displays the regional pattern of emissions. About 80 percent of the sulfur dioxide and 65 percent of the nitrogen oxides came from within the 31 States bordering or east of the Mississippi River. Figure 5 shows how these emissions have varied since 1900. Since 1940, sulfur dioxide emissions increased by about 50 percent and nitrogen oxides emissions about tripled. Throughout the same period, taller emission stacks became common, allowing pollutants to travel farther.

Figure 5 also shows a range of *projected* future emissions of these pollutants, assuming that current air pollution laws and regulations remain unchanged. *Actual* future emissions will depend on such factors as the demand for energy, the type of energy used, and the rate at which existing sources of pollution are replaced by newer, cleaner facilities. By 2030—the end of the projection period—most existing facilities will have been retired. Despite relatively strict pollution controls mandated for new sources by the Clean Air Act, **emissions of both sulfur and nitrogen oxides are likely to remain high for at least the next half century.**

The pollutants responsible for acid deposition can return to Earth in rain, snow, fog, or dew—collectively known as acid precipitation—or as dry particles and gases. **Averaged over the Eastern United States, about equal amounts of sulfur compounds are deposited in wet and dry forms.** However, in areas remote from pollution sources, such as the Adirondacks, wet deposition may account for up to 80 percent of the sulfur deposited; in urban areas near many sources of pollution the situation is reversed.[1]

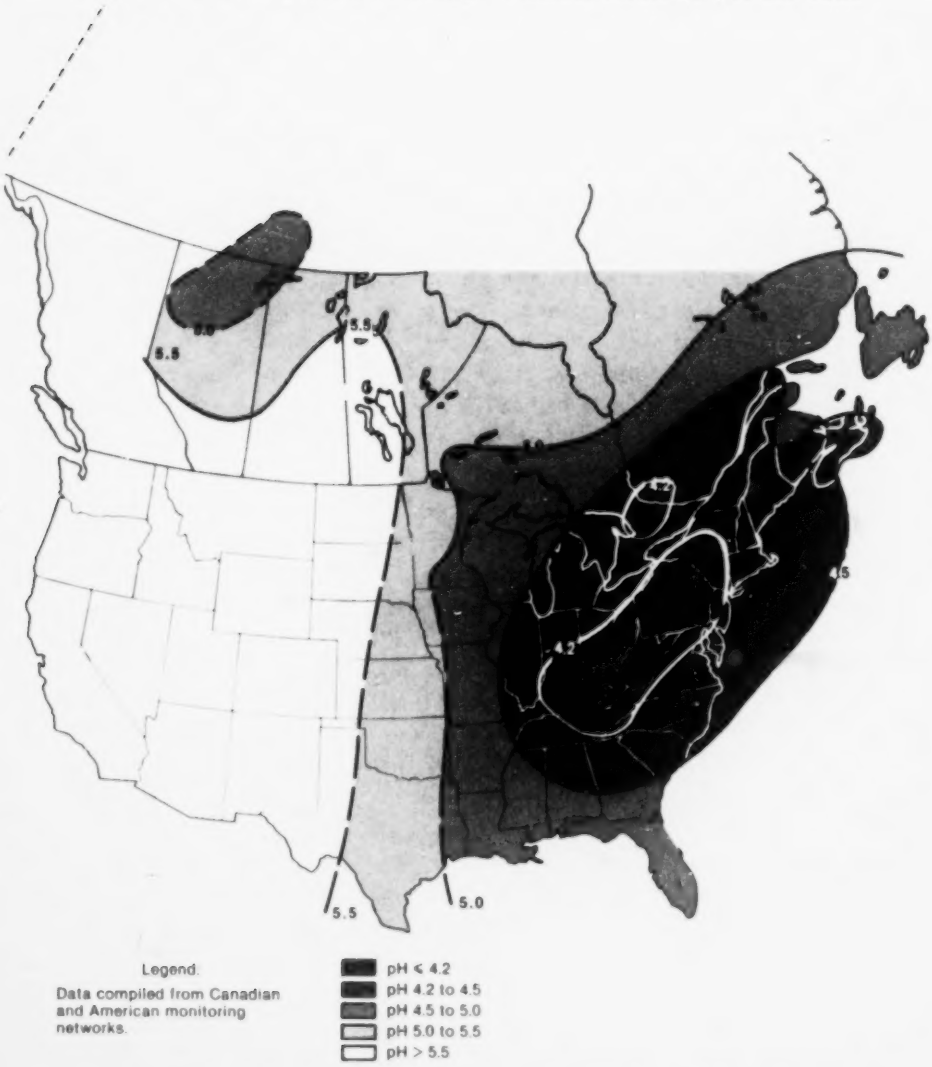
Pollutants emitted into the atmosphere can return to Earth almost immediately or remain aloft for longer than a week, depending on weather patterns and the pollutants' chemical interactions. During this time they move with prevailing winds, which in the Eastern United States tend to move from west to east and from south to north.

---

*Acidity is measured in pH units. Decreasing pH corresponds to increasing acidity, but in a nonlinear (logarithmic) way. Across the United States, average annual rainfall pH varies between about 4 and 6. Compared to a pH of 6, pH 5 is 10 times more acidic; pH 4 is 100 times more acidic; and so on. Referring to the shading in figure 2, pH 4.2 is twice as acidic as pH 4.5; about 6 times more acidic than pH 5; and about 20 times more acidic than pH 5.5.

[1]E. Altwicker and A. Johannes, "Wet and Dry Deposition in Adirondack Watersheds," *The Integrated Lake-Watershed Acidification Study: Proceedings of the ILWAS Annual Review Conference*, Electric Power Research Institute, EPRI EA-2827, 1983; and D. Fowler, "Removal of Sulfur and Nitrogen Compounds From the Atmosphere," *Ecological Impact of Acid Precipitation*, SNSF Project, Norway, 1980.

Figure 2.—Precipitation Acidity—Annual Average pH for 1980



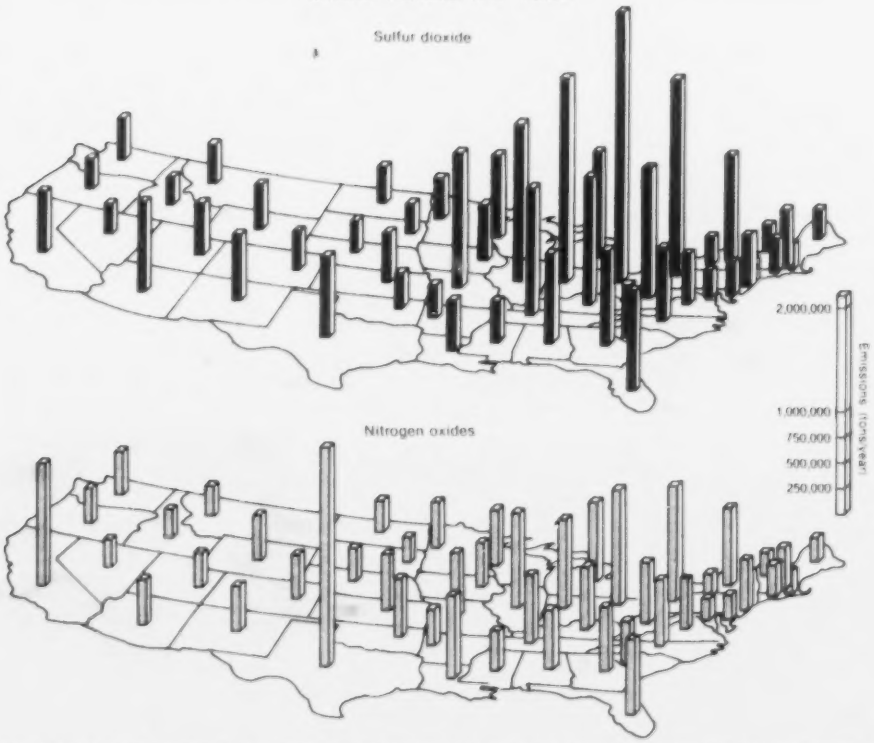
Preliminary analyses suggest that about one-third of the total amount of sulfur compounds deposited over the Eastern United States as a whole originates from sources over 500 kilometers (km) (300 miles) away from the region in which they are deposited. Another one-third comes from sources between 200 and 500 km (120 to 300 miles) away, and the remaining one-third comes from sources within 200 km (120 miles).[2]

Because pollution sources are unevenly distributed across the Eastern United States and Canada, the *relative* contribution of emissions from local, midrange, and distant sources varies by region. As shown in figure 6, sulfur

[2]J. Shannon, "Estimation of North American Anthropogenic Sulfur Deposition as a Function of Source-Receptor Separation," paper presented at the *NATO 14th International Technical Meeting on Air Pollution Modeling and Its Application*, Copenhagen, 1983.

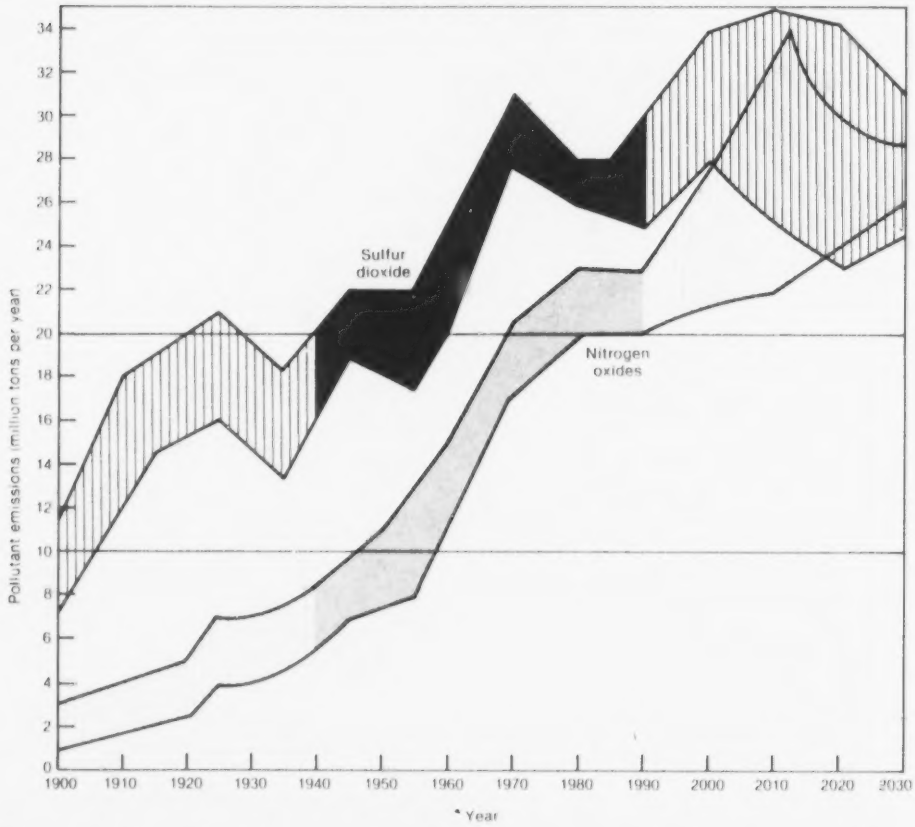
Figure 3.—Ozone Concentration—Daytime Average for Summer 1978

Figure 4.—Sulfur Dioxide and Nitrogen Oxides Emissions—State Totals for 1980



SOURCE: G. Gschwandtner, et al., "Historic Emissions of Sulfur and Nitrogen Oxides in the United States From 1900 to 1980," draft report to EPA, 1983.

Figure 5.—Sulfur Dioxide and Nitrogen Oxides Emissions Trends—National Totals, 1900-2030

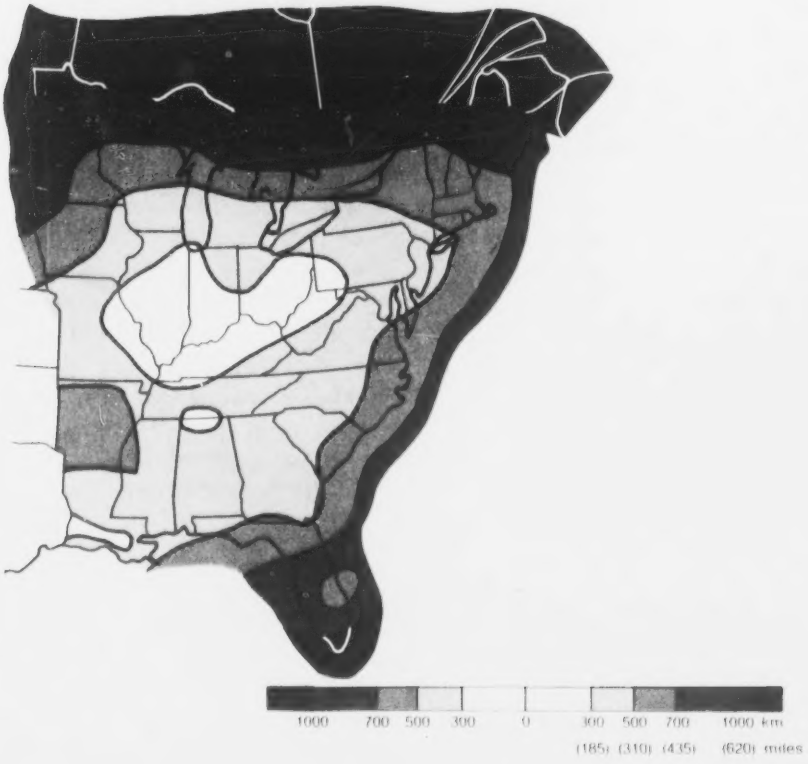


The graph above displays estimates of historical emissions, and projections of future emissions of sulfur dioxide and nitrogen oxides. Pre-1940 estimates and post-1990 projections are subject to considerable uncertainty. Projections of future emissions incorporate a wide range of assumptions about future economic growth, energy mix, and retirement of existing facilities; they assume no change in current air pollution laws and regulations.

SOURCES: Office of Technology Assessment. Composite from: U.S. Environmental Protection Agency, "National Air Pollution Emission Estimates, 1940-1980," 1982; G. Gschwandtner, et al., "Historic Emissions of Sulfur and Nitrogen Oxides in the United States From 1900 to 1980," draft report to the U.S. Environmental Protection Agency, 1983; *Emissions, Costs and Engineering Assessment*, Work Group 3B, United States-Canada Memorandum of Intent on Transboundary Air Pollution, 1982; and "Summary of Forecasted Emissions of Sulfur Dioxide and Nitrogen Oxides in the United States Over the 1980 to 2010 Period," ICF Inc. and NERA for the Edison Electric Institute, 1982; forecasts 1980 to 2030 by E. H. Pechan & Associates, Inc., for the Office of Technology Assessment, 1984.

deposition in the Midwest—a region with high emissions—is dominated by emissions from sources within 300 km (180 miles). The sulfur compounds that reach the less-industrialized New England region typically have traveled farther. The "average" distance—considering the contribution from both local and distant sources—is about 500 to 1,000 km (300 to 600 miles).

Figure 6.—Average Sulfur Transport Distances Across Eastern North America



The map above displays the "average" distance between the sources of sulfur dioxide emissions and the regions in which the sulfur compounds are eventually deposited. For each region of the Eastern United States and Canada, estimates of the sulfur deposited from all local, midrange, and distant emission sources are averaged to produce this map of typical transport distances. Such model-generated maps illustrate general patterns which will vary somewhat from year to year and model to model.

THE RISKS FROM TRANSPORTED AIR POLLUTANTS

The best documented and best understood effects of acid deposition are those on aquatic ecosystems. The sensitivity of a lake or stream to acid deposition depends largely on the ability of the soil and bedrock in the surrounding watershed to neutralize acid. Where the soil is very thin or has little neutralizing capacity, or where the terrain is so steep or rocky that rainfall runs right over it, the bodies of water within a watershed are at risk. When

the waters of a lake or stream become more acidic than about pH 5, many species of fish die and the ecosystem changes dramatically. This may be due to the acidity, to the metals (especially aluminum) released under acidic conditions, or to a combination of both.

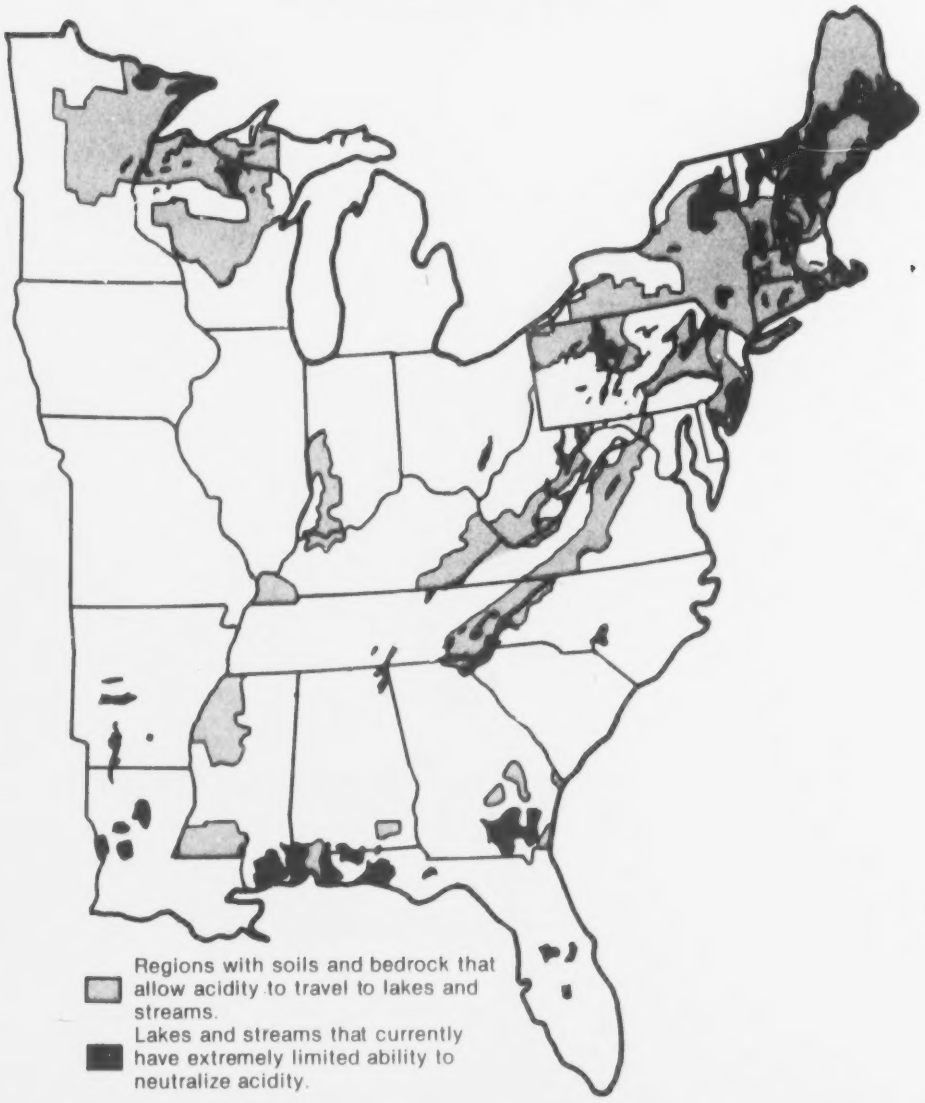
By categorizing the predominant soil and geological characteristics in each county of the Eastern United States, this study estimates the *potential* number of lakes and streams at risk from acid deposition. Because of the uncertainties involved, these numbers should be viewed as qualitative estimates only. In the 31 States bordering and east of the Mississippi River, roughly 25 percent of the land area contains soils and bedrock that allow acidity to travel through a watershed to lakes and streams (see fig. 7). About 17,000 lakes and 112,000 miles of streams lie within these sensitive areas. As a "best guess," about half of these lakes and streams have such limited ability to neutralize acid that they will acidify if enough acid-producing pollutants are deposited. **We estimate that about 3,000 lakes and 23,000 miles of streams— or about 20 percent of those in the sensitive areas— are now extremely vulnerable to further acid deposition or have already become acidic.** New England has the greatest percentage of lakes and streams considered sensitive to acid deposition. The Upper Midwest also has large numbers of sensitive lakes, and many sensitive streams are found in the Central Appalachian region.

In addition to the acidification of aquatic ecosystems, transported air pollutants have been linked to harmful effects to terrestrial ecosystems. **Broad forested areas subjected to elevated levels of acid deposition, ozone, or both have been marked by declining productivity and dying trees, although it is uncertain how much of this is due to airborne pollutants.** Figure 8 documents significant growth declines in several tree species beginning about 1960 throughout the East from Vermont to Tennessee. Acid deposition, ozone, heavy-metal deposition, drought, severe winters, or a combination of these stresses are possible causes under investigation.

Acid deposition might be harming trees in two ways: either directly (e.g., by removing nutrients from leaves), or indirectly, by altering the soils on which trees grow. If acid deposition harms trees directly, much of the forested area of the Eastern United States is at risk, with the greatest risk in high elevation areas where deposition is often greatest. If acid deposition affects forest soils, forests growing on nutrient-poor, naturally acidic soils are of greatest concern. This study estimates that such soils cover about 15 to 20 percent of the land area of the Eastern United States, primarily parts of New England, the Upper Midwest, and the South. Acid deposition might be stripping such essential nutrients as calcium and magnesium from these soils, or releasing metals, such as aluminum, that are toxic to plants. Whether this nutrient loss or release of metals from the soil is large enough to affect forest productivity at current levels of acid deposition is unknown.

A large area of U.S. forests is also exposed to elevated ozone concentrations. Ozone has been shown to damage tree foliage and reduce the growth rates of certain sensitive tree species. But its cumulative effect on *forest pro-*

Figure 7.—Regions of the Eastern United States With Surface Waters Sensitive to Acid Deposition


Regions with soils and bedrock that allow acidity to travel to lakes and streams.
Lakes and streams that currently have extremely limited ability to neutralize acidity.

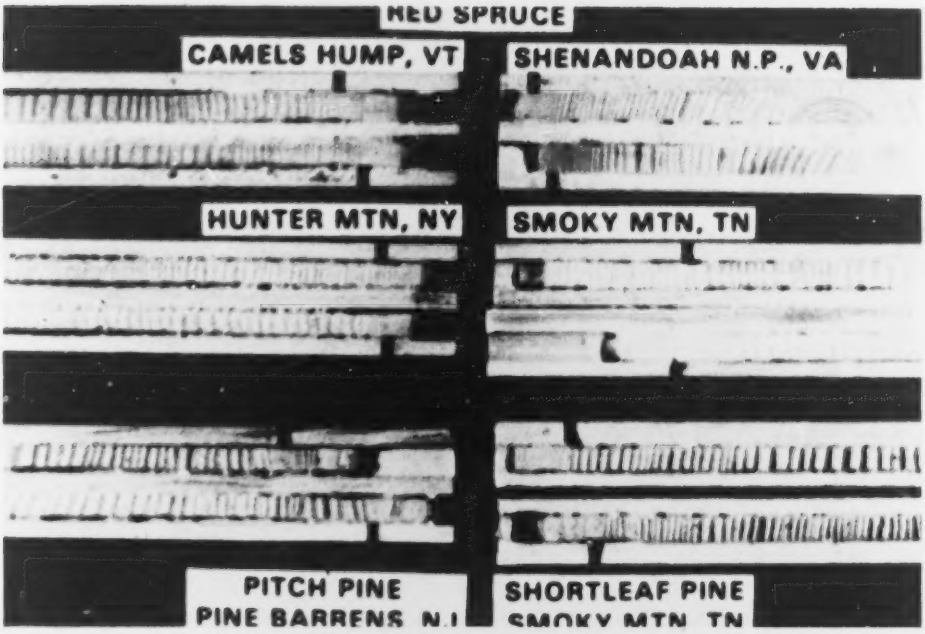
The regions shaded light grey contain soils and bedrock that allow acidity to travel through a watershed to lakes and streams. Due to local variations, however, not all water bodies within these areas are sensitive to acid deposition. Likewise, some sensitive water bodies may be located outside the light grey areas. The dark areas contain lakes and streams that currently have such limited ability to neutralize acid[a] (as measured by water quality surveys) that they are now extremely vulnerable to further acid deposition or are already acidic.

[a]Regions with surface waters that have mean annual alkalinity less than 100 microequivalents per liter.

SOURCES: Office of Technology Assessment. Composite map from the Institute of Ecology, "Regional Assessment of Aquatic Resources at Risk From Acid Deposition," OTA contractor report, 1982; and J. Omernik, "Total Alkalinity of Surface Water," draft map prepared to the U.S. Environmental Protection Agency, 1983.

99-414 O - 84 - 3 : QL 3

Figure 8.—Recent Forest Productivity Declines Throughout the Eastern United States



The photograph shows corings from three softwood tree species growing on six sites across the East from Vermont to Tennessee. The corings show normal growth—widely spaced tree rings—until about 1960 (marked with a stripe). From about 1960 to the present the tree rings have markedly narrowed, evidence of decreased growth. Concerns have been raised that elevated levels of ozone and acid deposition in these regions may be involved in the observed declining productivity. As of now, the cause is unexplained.

SOURCE: Arthur Johnson, University of Pennsylvania, Samuel McLaughlin, Oak Ridge National Laboratory

ductivity over the lifetime of trees—half a century or more—is difficult to predict.

Transported air pollutants adversely affect agricultural productivity. Up to 90 percent of the damage to crops from air pollutants may be due to ozone. Large areas of the United States, including much of the Midwestern Corn and Soybean Belts, are exposed to high levels of ozone. This study estimates that if ozone levels were reduced to their natural background levels, corn yields would have been 2 percent higher, wheat yields 5 percent higher, soybean yields 13 percent higher, and peanut yields 24 percent higher. Based on the value of these crops, **ozone causes about a 6- to 7-percent loss of U.S. agricultural productivity.**

Many areas of abundant agricultural production, such as Illinois, Indiana, and Ohio, also receive high levels of acid deposition. Some experiments using simulated acid rain have demonstrated reduced yields of agricultural crops, but others have found no effect.

Airborne pollutants accelerate the deterioration of many economically important materials. Sulfur oxides damage iron and steel, zinc, paint, and stone; certain types of rubber are susceptible to ozone. Pollution-induced damage is difficult to quantify because it cannot be distinguished readily from the weathering effects of the natural environment. The bulk of materials damage is thought to be caused by pollutants emitted *locally*. Regions at greatest risk are urban areas (especially those in industrial regions) and areas with historically significant buildings and monuments. One recent study estimated that reducing sulfur dioxide emissions in selected urban areas to achieve concentrations 25 to 30 percent below the current air quality standard could yield materials-related benefits of hundreds of millions of dollars annually.[3] Pollutant effects on unique or historic structures may be irreparable, and thus cannot be evaluated solely in monetary terms.

Air pollutants—along with natural causes such as humidity, fog, and dust—can significantly impair visibility. They reduce contrast, discolor the atmosphere, and obscure distant objects. **In the Eastern United States, airborne sulfates appear to be the single greatest contributor to reduced visibility, causing about 50 percent of visibility impairment annually, and about 70 percent during the summer.**[4] In the West, windblown dust and nitrogen oxides can also impair visibility significantly.

Air concentrations of sulfur dioxide, nitrogen oxides, and ozone are currently regulated to protect human health. No standards exist for airborne sulfates, which may also pose a threat to human health. At high exposure levels, sulfates can aggravate existing heart and lung conditions such as asthma. Several statistical studies comparing historical air pollution data and health records found a correlation between airborne sulfate levels and mortality, but whether there is a causal link between the two is not clear. For instance, elevated sulfate levels often occur with other airborne fine particles, one or more of which might be causing harm.

Disagreement exists within the scientific community over the significance of airborne sulfates to human health. **Some researchers conclude that there is a negligible effect at prevailing concentrations; others have found a significant association—several percent of annual mortality, primarily among people with preexisting cardiac or respiratory problems.** By combining the various estimates, this study concludes that a reasonable estimate of the magnitude of health risk posed by current levels of sulfates and other particulates is about 50,000 premature deaths (2 percent of total deaths) per year in the United States and Canada. This estimated health risk from transported air pollutants is a measure of *possible* harm. It can neither be confirmed nor disproven until further research is conducted.

---

[3] E. H. Manuel, Jr., et al., "Benefits Analysis of Alternative Secondary National Ambient Air Quality Standards for Sulfur Dioxide and Total Suspended Particulates," Mathtech, Inc., report submitted to the U.S. Environmental Protection Agency, OAQPS, 1982.

[4] For example, see M. Ferman, et al., "The Nature and Source of Haze in the Shenandoah Valley/Blue Ridge Mountain Area," *J. Air Pollution Control Assoc.* 31:1074-1082, 1981; and U.S. Environmental Protection Agency, *Protecting Visibility, An EPA Report to Congress*, EPA 450/5-79-008, 1979.

Acidified waters can dissolve metals and toxic substances from soils, rocks, conduits, and pipes, and subsequently transport them into drinking water systems. Municipal water supplies can be monitored and corrected quite easily; potential problems with well water in rural areas are more difficult to detect and mitigate. Although acid deposition has not been proven to be the cause, water samples from a few areas in the Adirondacks and New England receiving high levels of acidity have contained lead concentrations exceeding the health-based standards.

THE RISKS OF CONTROLLING TRANSPORTED AIR POLLUTANTS

The above discussion of the risks from transported air pollutants relies heavily on such words as "could" and "might" because at present, we can only make educated guesses about the scope and severity of the problem. For example, scientists are certain that acid deposition damages lakes and streams, and that ozone damages crops. But they cannot say with certainty how many lakes and streams and what quantity of crops have been damaged. Nor can they forecast with confidence what these damages will be in the future. Part of the difficulty is the uncertainty about the extent to which resource damage is cumulative—some types of resource damage might worsen even if levels of acid deposition remain about the same.

These uncertainties are compounded by imprecise knowledge of the transport and transformation of pollutants emitted throughout the Eastern United States and Canada. Scientists have devised atmospheric transport models to simulate the movement of sulfur emissions. But even with these sophisticated tools, scientists can only *estimate* the amount of sulfur pollution transported from one large region to another, over seasonal to annual time scales. Similarly, scientists cannot confidently predict the degree to which emissions reductions in one region would reduce deposition in another.

Intertwined with the scientific uncertainties about the benefits of a control program are disagreements over values. Few would deny that there are significant environmental risks associated with transported air pollutants. **But there are also risks associated with controlling these pollutants—the risks that the benefits from reducing emissions do not justify the economic and social costs.**

Various groups and individuals differ sharply on where the balance should be struck between protecting the environment and protecting other areas of economic well-being. There is little agreement on the intrinsic worth of resources or the equitable distribution of costs to protect those resources. Unfortunately, more accurate atmospheric transport models or a better understanding of the level of emissions required to protect sensitive resources will do little to solve such questions of values.

To put the risks and uncertainties of controlling transported air pollutants into context, this study examines a range of programs to reduce emissions, focusing on the direct and indirect costs for specific regions of the United States and the country as a whole.

Most of the proposals introduced during recent sessions of Congress would control sulfur dioxide emissions, since sulfur compounds contribute twice as much acidity to rainfall in the Eastern United States as nitrogen compounds and are more strongly implicated with a variety of adverse effects. This study estimates that the annual costs to reduce sulfur dioxide emissions in the 31 States bordering and east of the Mississippi River could range from about $1 billion (or less) for about a 10- to 20-percent reduction, to about $3 billion to $6 billion for a 35- to 45-percent reduction below 1980 emissions levels by 1995.

The larger control programs could have several significant consequences. The average cost of electricity will increase by several percent. Certain utilities and electricity-intensive industries might be financially strained. And, if utilities achieve emissions reductions in part by switching to low-sulfur coal, jobs would be displaced from areas where coal high in sulfur content is mined to areas producing low-sulfur coal.

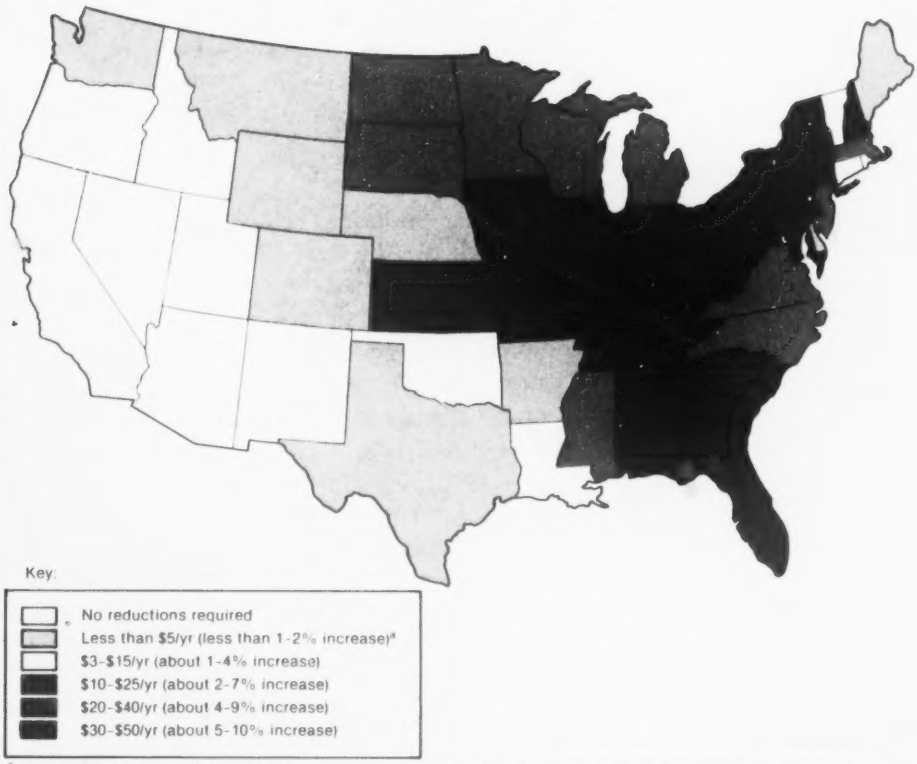
Because electric utilities account for about three-fourths of the sulfur dioxide emitted in the Eastern United States, most current legislative proposals would require significant reductions in utility emissions. In particular, utilities in the Midwestern States, which tend to burn high-sulfur coal, would bear the greatest impact of an emissions control program. Ultimately, these costs would be passed on to consumers in the form of higher utility bills. For example, this study estimates that **10 million tons of sulfur dioxide emissions could be eliminated from existing sources nationwide for about $3 billion to $4 billion per year, increasing average electricity rates by 2 to 3 percent.** These rate increases would vary by State, as shown in figure 9. Consumers in some States would see no increases, while others would pay increases over three times the national average. **If the projected future growth in emissions must also be offset through reductions from current emitters (an additional 1 million to 3 million tons per year by 2000), average residential electricity costs could rise by about 4 to 5 percent, with increases of 10 to 15 percent in several States.**

An emissions control program could strain the financial resources of a number of electric utilities, particularly if State regulatory policies prohibit them from quickly passing on control costs to consumers. Based on selected economic ratings and the range of current State policies, utility sectors in several States might be relatively vulnerable to the additional capital requirements for pollution control equipment. Few of the States with the highest percentages of economically vulnerable utilities, however, are allocated extensive emissions reductions under current acid rain proposals.

Some firms and industries that rely heavily on electricity could become less competitive if their electricity rates were to increase substantially above rates in other parts of the country. Of greatest concern are those that produce electrometallurgical products, zinc and aluminum, alkali- and chlorine-based chemicals, and industrial gases.

If a control program is enacted that allows each utility to freely choose its own method of achieving emissions reductions, some utilities will choose to switch from burning high-sulfur coal to low-sulfur coal. **Under such a**

Figure 9.—Cost of Reducing Sulfur Dioxide Emissions by 10 Million Tons per Year, Nationwide Increases in Annual-Average Electricity Bills for a Typical Residential Consumer



[a]Average annual cost increase (1982 dollars) for a typical residence consuming 750 kWh/month electricity. Percentage rate increases in each State are calculated from State average 1982 electricity costs (ranging from about $200 to $900/yr. United States average about $600/yr).

SOURCE: Office of Technology Assessment, based on analyses by E. H. Pechan & Associates, Inc.

"freedom-of-choice" program to eliminate 10 million tons of emissions per year, future levels of high-sulfur coal production could fall 10 to 20 percent below 1980 levels. Employment in regions that mine high-sulfur coal could be 20,000 to 30,000 jobs below projected levels. An equivalent number of jobs would open up in Eastern and Western States that mine low-sulfur coal. **Legislation that mandates the use of high-removal control technology could minimize such dislocations, but could increase total program costs by about $1.5 billion per year.**

POLICY OPTIONS

Four approaches for congressional action on acid deposition and other transported air pollutants are discussed below:

A. Mandating emissions reductions to further *control the sources* of transported pollutants.
B. Liming lakes and streams to *mitigate some of the effects* of acid deposition.

C. Modifying the Federal acid deposition research program to *provide more timely guidance* for congressional decisions.
D. Modifying existing sections of the Clean Air Act to *enable the Environmental Protection Agency, States, and countries to more effectively address transported air pollutants other than acid deposition.*

Congress could choose to adopt some or all of these approaches in its consideration of clean air legislation. **A comprehensive strategy to address transported air pollutants might well include options from all four of the approaches discussed below.**

Approach A: Mandating Emissions Reductions To Further Control the Sources of Transported Pollutants.

Discussion

Legislated emissions reductions could range from modest reductions to keep emissions at—or somewhat below—current levels, to large-scale control programs. In choosing an appropriate program, Congress will need to weigh the risks of potential resource damage, the risks of inefficient control expenditures, and the distribution of these risks among different groups and regions of the country.

Mandating further emissions reductions would require Congress to make a number of interrelated choices. These include decisions about which pollutant emissions to reduce, from what regions, by how much, and over what time period. Congress would also need to choose specific policy mechanisms to implement the reductions, allocate their costs, and address undesired secondary consequences of emissions reductions.

This study has divided these decisions into eight distinct questions, which can be answered in different ways to produce different control programs. Three representative control programs are presented at the end of the discussion of this approach.

- **Which Pollutants Should Be Further Controlled?**

In the East, sulfur compounds currently contribute about twice as much acidity to precipitation as nitrogen compounds. Moreover, throughout the growing season, plants use much of the deposited nitrogen as a nutrient, making sulfur compounds responsible for a still larger share of acidity reaching lakes and streams. Sulfur compounds damage materials and in the particulate form (sulfate) reduce visibility and pose risks to human health. Both this study and a recent report from the National Academy of Science conclude that decreasing sulfur dioxide *emissions* would reduce sulfur *deposition* by roughly the same proportion. For these reasons, **sulfur dioxide is the logical focus for a program to control acid deposition in the Eastern United States.**

Adding nitrogen oxides controls to the program is a reasonable next step if additional resource protection is desired. Nitrogen oxides emissions are expected to increase more rapidly over the next few decades than sulfur dioxide emissions. During the spring—a vulnerable period for aquatic life—both nitrogen and sulfur compounds found in melting snow travel freely

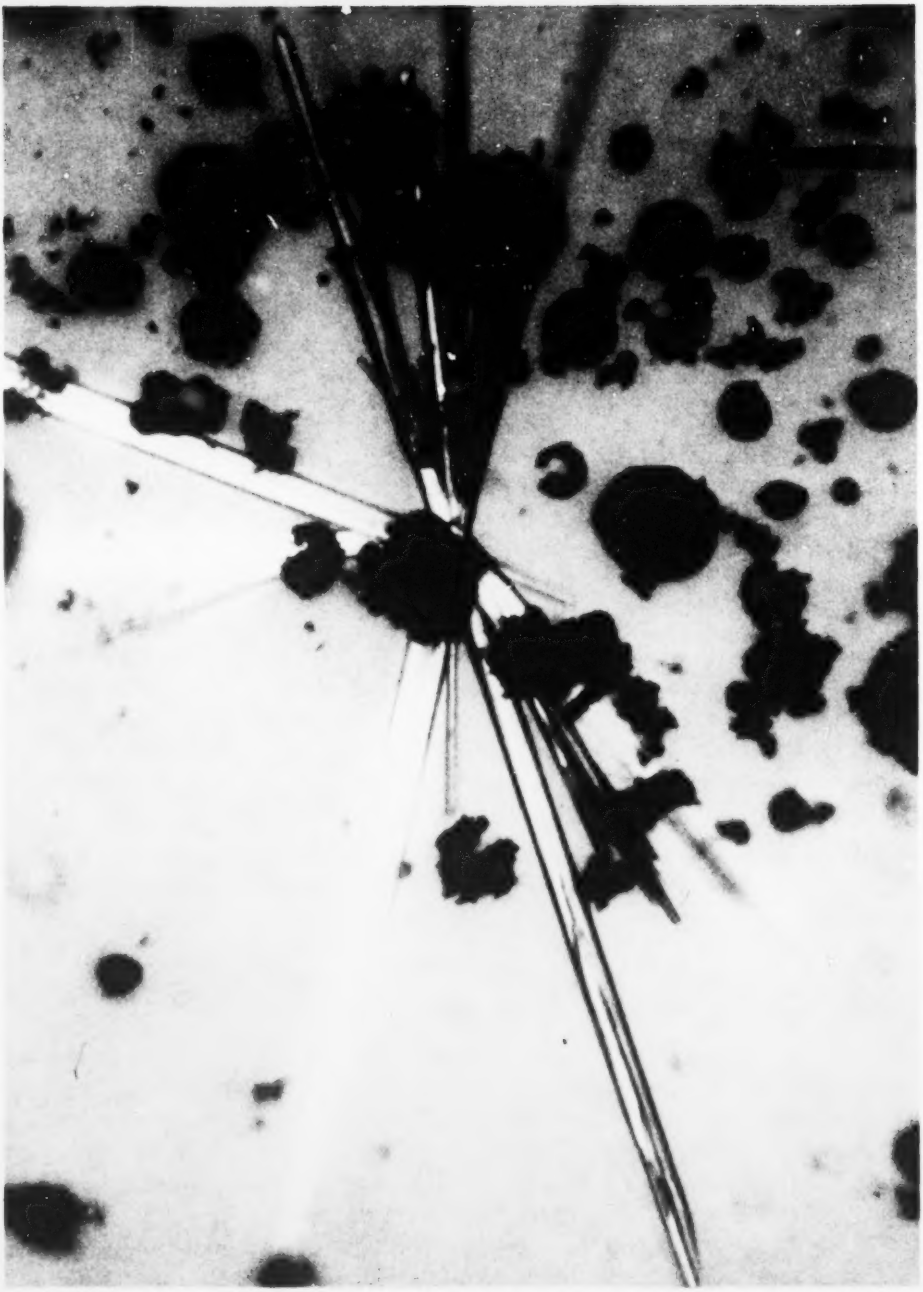


Photo credit: Roger Chen

A sulfate particle transformed from sulfur dioxide gas in a water droplet. The black soot (fly ash) speeds the conversion. Sulfate particles, when airborne, are part of a "pollutant mix" that degrades visibility and poses risks to human health. These small particles can be suspended for several days, gradually settling to Earth during dry periods, or rapidly washed from the air if it rains. In either form—wet or dry—sulfur compounds are major contributors to acid deposition.

through watersheds to bodies of water and contribute to acidification. Reducing nitrogen oxides emissions would also help lower regional ozone levels.

In the West, nitrogen compounds may contribute as much or more to precipitation acidity as sulfur and, thus, should be considered if a nationwide control program is desired.

- **How Widespread Should a Control Program Be?**

Both pollutant sources and resources sensitive to the effects of transported air pollutants are scattered across the Eastern United States. Because pollutants can travel hundreds of miles, programs to protect sensitive resources must encompass much of this area. Four regions are potential candidates:

1. The 21 States east of the Mississippi River and north of (and including) Tennessee and North Carolina, which receive the greatest levels of acidity. This region excludes several contiguous States that are large emitters.
2. The 31 States bordering and east of the Mississippi River, which emit 83 percent of the Nation's sulfur dioxide and 66 percent of its nitrogen oxides. This region has been the focus of most legislative proposals to date.
3. The 37 States east of the Rocky Mountains, which emit 89 percent of the Nation's sulfur dioxide and 85 percent of its nitrogen oxides.
4. The 48 contiguous States.

- **What Level of Pollution Control Should Be Required?**

Possible choices for further emissions control programs range from modest control (which would hold overall emissions at current levels) to large-scale emissions reductions. The decision of how much to reduce emissions involves two important components: the *scientific* question of the relationship between emissions reductions and resource protection, and the *policy* question of the socially desirable level of protection.

Most of the control programs proposed in recent sessions of Congress have aimed at reducing emissions by 8 million to 10 million tons per year below 1980 levels. Although the effects of such reductions are hard to predict, this study estimates that **reductions of 8 million to 10 million tons per year below 1980 levels are likely to protect *all but the most sensitive aquatic resources* in many areas receiving high levels of acid deposition. Those areas now receiving the *highest* levels of deposition—western Pennsylvania, for instance—would also benefit from reductions of this magnitude, though some risk of damage would still be present.** Risks of damage to forests, agriculture, materials, and health would likewise be reduced, and visibility would improve. A control program of this magnitude would cost about $3 billion to $6 billion per year. Costs would rise steeply if greater resource protection were desired.

More modest reductions, eliminating 2 million to 5 million tons of sulfur dioxide per year from existing sources, could be achieved for about $1 billion per year. Such a program would, at a minimum, offset expected emissions increases from utility and industrial growth, and might decrease emissions

by 2 million to 3 million tons per year by the year 2000. Some resource improvement might result, or degradation might be slowed, but it is impossible at present to gauge by how much.

- **By What Time Should Reductions Be Required?**

Significant emissions reductions from existing sources would take at least 6 or 7—and possibly 10 or more—years to implement, given the planning, contracting, construction, and other steps that would be necessary. Waiting 4 to 6 years for the results of the Federal research program could increase the time required to reduce deposition to 10 to 16 years or more. Although resource damage will continue, it is impossible to predict how much damage might occur to resources during this additional delay, or how much more efficient a control program designed at the end of the decade might be. Because of the time needed for planning, **a control program initiated in the near future would not involve major expenditures for at least 5 years.** Control legislation could be modified with relatively modest cost penalties until 2 to 3 years before the compliance date, at which point major construction expenditures would have to begin.

- **What Approach to Control Should Be Adopted?**

Two general approaches are currently used for environmental regulation: "source-based" regulations and "environmental quality" standards. Source-based programs directly regulate the quantity of pollution allowed from emission sources. Programs based on environmental quality standards set goals or standards for resource exposure to pollutants; steps are then taken to meet these goals. Such a program requires a well-developed understanding of the transport, transformation, and effects of pollutants. **The knowledge needed to *implement* an environmental quality standard for acid deposition is not yet available and may not be for at least a decade. This study therefore concludes that a source-based program, which regulates emissions directly, is the only approach available now for controlling acid deposition.** Such a program could specify, for example, maximum allowable emission rates (in pounds of pollutants per quantity of fuel burned) or maximum allowable statewide emissions (in tons of pollutants per year). A source-based approach could also limit emissions by mandating the use of specific technologies such as scrubbers or coal washing.

- **How Should Emissions Reductions Be Allocated?**

If Congress decides to mandate emissions reductions directly, it can either set a reduction formula that applies to all or some of the sources within a State, or it can set an overall reduction level for each State and allow the State to allocate emissions reductions within its borders. Congress could also set specific environmental protection goals, including economic considerations, and direct the Environmental Protection Agency (EPA) to develop an allocation plan to meet those goals.

Allocation formulas can take many different forms. For example, emissions could be reduced by an equal percentage in each State regardless of whether

the State is a relatively high or low emitter. Alternatively, allowable emission *rates* could be set, requiring the greatest reductions from sources that emit the greatest amounts of pollution per unit of fuel burned or similar measure. Most legislative proposals to date have followed the latter approach. A formula could be based on utility emissions alone or statewide total emissions. Allocation formulas differ in their resulting geographic patterns of emissions reductions and administrative complexity.

- **Who Pays the Costs of Emissions Reductions?**

The full costs of pollution control could be borne by those sources required to reduce emissions. **This "polluter pays" philosophy is the traditional approach to environmental regulation; in the case of transported air-pollutants, however, the culpability of particular sources for specific resource damage is difficult to assess. Thus, some advocate spreading the costs of a control program to a larger group through such mechanisms as a tax on electricity or emissions.** Revenues would go to a trust fund, to be used to help finance control technology. Such cost-sharing mechanisms, however, can impose costs on areas that have taken action in the past to control emissions or that already have low emissions.

- **What Can Be Done To Mitigate Employment and Economic Effects of a Control Policy?**

To reduce employment dislocations resulting from increased demand for low-sulfur coal, Congress could require the use of control technologies designed for high-sulfur coal or require plants to use locally mined coal. Mandating the use of scrubber technologies could increase the costs of emissions reductions by about 25 to 50 percent for a large-scale program. Alternatively, if utilities are allowed to switch from high- to low-sulfur coal, workers or communities affected by the switch could be compensated..

To reduce the financial strain on specific utilities or their customers, Congress could establish a trust fund (as described under the previous question) to help pay for pollution control equipment.

Options

Congress could design a control program by selecting alternatives from each of the eight decision areas summarized above. Obviously, many combinations are possible; three representative options are presented below.

Option A-1: Mandate small-scale emission reductions.

A small-scale program would logically focus on further controlling sulfur dioxide emissions—the major manmade acidifying pollutant in the Eastern United States—within a 20- to 30-State region producing and receiving the greatest acid deposition. Two million to three million tons of sulfur dioxide emissions could be eliminated from existing sources for under $1 billion annually; 5 million tons per year could be eliminated for about $1 billion to $1.5 billion annually.

Control programs of this size would offset expected emissions increases of 2 million to 3 million tons per year by the year 2000, holding levels of acid deposition about constant or reducing them slightly below current levels. Such a program could be enacted alone, or as the first phase of larger programs discussed below, making the latter phase contingent on results of ongoing research.

Option A-2: Mandate large-scale emissions reductions.

A large-scale program similar to those proposed during recent sessions of Congress would reduce sulfur dioxide emissions by 8 million to 12 million tons per year. It could be confined to the Eastern United States or applied nationwide and could also include reductions in nitrogen oxides emissions.

We estimate that such a program would protect all but the most sensitive lakes and streams in many areas receiving high levels of acid deposition. Areas receiving the greatest levels of acidity, however, still might not be completely protected. Risks of damage to forests, crops, materials, and health would also be reduced and visibility would improve.

The costs of such a program could range from $2 billion to $3 billion per year to $6 billion to $8 billion per year, depending on its size and design. Congress might choose to spread some portion of control costs across a larger group than just those sources required to reduce. A trust fund generated by a tax on electricity or pollutant emissions could be established for this purpose. Congress could also mandate or subsidize the use of control technology to minimize job dislocations associated with switching from high- to low-sulfur coal.

Option A-3: Specify environmental quality goals or standards.

Rather than mandating specific emissions reductions, Congress could set environmental protection goals (including economic considerations, if desired) and direct EPA to establish a plan to achieve them. Because the tools needed to establish such a program are not yet available, this approach would not be feasible in the near future. It could, however, be preceded by small-scale, mandated reductions described earlier if Congress desired some emissions reductions within a decade. The compliance date for the remainder of the program might be set for early in the next century, which might allow enough time to develop the necessary modeling techniques, establish the standard, and achieve the required reductions.

Approach B: Liming Lakes and Streams To Mitigate Some of the Effects of Acid Deposition.

Discussion

Several chemicals can be used to temporarily treat acidified aquatic ecosystems. Mitigating the effects of acid deposition on other sensitive resources (e.g., forest soils) is not yet technically or economically feasible.

Adding large quantities of lime to water bodies has been effective in counteracting surface water acidification in parts of Scandinavia, Canada,

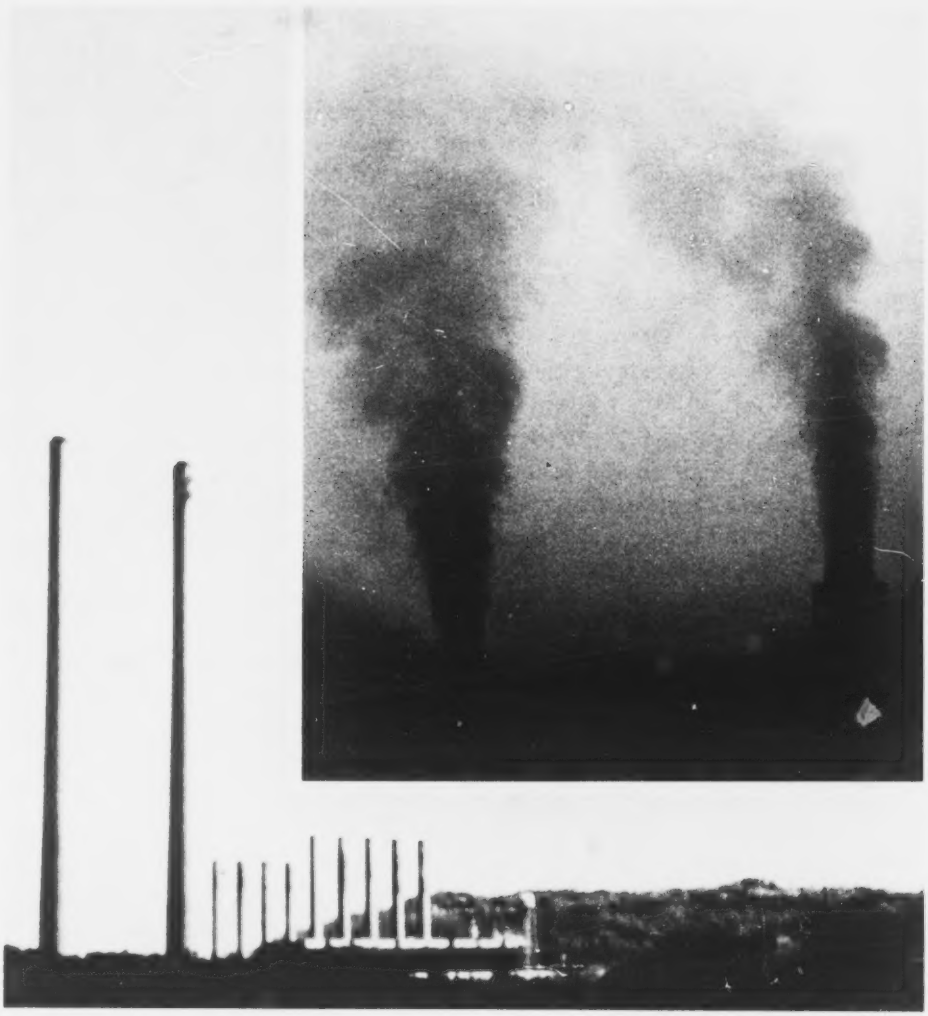


Photo credits: Ted Spiegel

Sulfur dioxide being emitted from the Kingston powerplant in Tennessee. Sulfur dioxide gas is invisible to the naked eye, but can be seen in the inset (upper right) with the aid of a special camera filter. The two 1,000-ft smokestacks were built in 1976, replacing the nine smaller stacks built with the plant during the mid-1950's. The tall stacks help the plant comply with local air-quality regulations, but disperse pollutants more widely.

and the United States. These programs have significantly improved water quality at a number of lakes and ponds, permitting fisheries to be maintained. Once begun, liming must be repeated every few years to prevent reacidification and buildup of toxic metal concentrations. Not all lakes and streams, however, respond sufficiently to liming to reestablish aquatic life, and little is known about the ecological consequences of continued liming.

Federal funding over the last several years permitted only a few research projects on the effects of liming to be undertaken each year. Several bills in-

troduced during recent sessions of Congress proposed additional Federal support for mitigation programs. The Administration recently proposed about $5 million for liming research for fiscal year 1985. Funding at this level would provide more information on the feasibility of liming as a way to counteract the effects of acid deposition on sensitive lakes and streams. Such information would be extremely useful *regardless* of whether an emissions control program is adopted. Specific options available to Congress for promoting mitigation research are listed below.

Options

Option B-1: Expand current Federal mitigation research efforts under the National Acid Precipitation Assessment Program (NAPAP).

Federal funding through NAPAP for research on mitigation techniques—primarily liming—has been very modest. Congress could make more research funds available to expand this program so that it would include lakes and streams of varying geological, geographic, and biological conditions. Long-term monitoring of biological and chemical changes in limed water bodies should be an integral part of the program to determine frequency and effectiveness of liming, as well as secondary effects of this chemical alteration. Such a program could aid the Fish and Wildlife Service in developing guidelines that States, local communities, and private interests could use to mitigate the effects of acidification.

Option B-2: Expand Federal-State cooperative efforts for treating acidified surface waters and assessing results.

Funds to assess the effectiveness of water treatments are available under the existing Dingell-Johnson Act, which imposes a 10-percent tax on the wholesale cost of fishing tackle for projects to benefit recreational fishing. However, States currently do little mitigation-related work with these funds. Congress could direct additional resources towards mitigation activities by placing requirements on the use of these funds, by making more funds available, or by establishing new Federal-State cooperative programs.

Option B-3: Establish demonstration projects for acidified water bodies on Federal lands.

Congress could direct the Fish and Wildlife Service or the Forest Service to establish programs to treat selected lakes and streams on Federal lands and monitor their chemical and biological responses.

Approach C: Modifying the Current Research Program (NAPAP) To Provide More Timely Guidance to Congress.

Discussion

Under the Acid Precipitation Act of 1980 (Title VII of the Energy Security Act of 1980, Public Law 96-294), Congress created an interagency task force to carry out a comprehensive 10-year research and assessment program

Photo credit: Ted Spiegel

This researcher is measuring the acidity of a lake in the Adirondack Mountains, N.Y. Research sponsored by both the Federal interagency research program and such private groups as the Electric Power Research Institute has helped scientists understand some of the causes and consequences of acid deposition. A continuing, strong research program is needed, regardless of the outcome of emissions control legislation. Two important areas include: 1) effective methods to treat already damaged lakes and streams (options B-1 to B-3), and 2) research on combined air pollution stresses to forests (option C-3).

on acid deposition. After 2 years of planning, the task force presented Congress with the National Acid Precipitation Assessment Plan. According to this plan, an integrated, policy-related assessment is to be completed by 1987 and updated by 1989—a schedule that many members of Congress and public interest groups feel is too slow.

Several bills have proposed accelerating the plan. Such action has several disadvantages and is unlikely to provide guidance to policymakers in the short term. Redesigning the research schedule would consume a substantial amount of time and effort; moreover, many of the currently planned studies cannot be completed in the shorter times suggested. Accelerating the program might limit longer term studies, which are of great importance for evaluating and implementing any control program eventually put in place.

A strong, continuing research program is a necessary part of *any* strategy Congress might choose to address the problem of acid deposition. Current Federal research efforts could be strengthened in several ways. Option C-1 below is appropriate if Congress decides to wait several years to reconsider an emissions control program; option C-2 is appropriate if Congress acts now to control acid deposition. Option C-3 could be adopted in either event.

Options

Option C-1: Establish a two-track research program.

In the absence of a legislated emissions control program, Congress could establish a policy assessment effort to be completed at an earlier date. The program could be assigned to either the existing interagency task force, or to a separate group entirely. Such a "two-track" program, leaving the current program largely intact, could analyze a series of control options within 2 or 3 years. This effort would need to begin almost immediately and therefore rely primarily on currently available information. Though this assessment would, by necessity, be based on less complete information than one begun several years from now, it could provide a common set of control costs estimates, deposition reductions, and similar information about alternative scenarios for policymakers to consider. The assessment could provide important information for considering the *initiation* of a control program; the present, longer term effort would be completed in time to reevaluate a control program, if enacted, before major expenditures occurred.

Option C-2: Redirect the research program if a control program is legislated.

Though the National Acid Precipitation Program was established as a long-term (10-year) effort, the enabling legislation does not explicitly address its fate if control legislation is passed. Maintaining the program in such a case, with some modifications, would have several benefits. Continued long-term monitoring and research will be necessary to evaluate the effectiveness of a control program after its passage, providing the opportunity to modify the control strategy if necessary. Also, with some redirection, the program would provide valuable guidance on implementing the control plan through the 1990's.

Option C-3: Broaden the ongoing research to include other transported air pollutants.

The Acid Precipitation Act of 1980 established an innovative, interagency research program addressing acid deposition. However, the effects of acid deposition on many resources—in particular, forests, crops, and materials—are difficult to separate from other pollutant stresses. Similarly, reducing emissions provides benefits in addition to those associated with reduced levels of acid deposition, for example, improved visibility. Congress could use the existing interagency structure and broaden NAPAP's mandate (and funding) to include research on other air pollutants. For example, recent studies showing forest productivity declines in the Eastern United States have raised concerns about the combined stress from acid deposition, ozone, and heavy-metal deposition. An integrated approach to studying such pollutant mixes could both strengthen the current research effort, and, perhaps more important, provide guidance to Congress about the more general problem of transported air pollutants.

Approach D: Modifying Existing Provisions of the Clean Air Act To Enable EPA, States, and Countries To More Effectively Address Transported Air Pollutants Other Than Acid Deposition.

Discussion

The Clean Air Act was designed to control *airborne* concentrations of pollutants known to endanger public health and welfare. No provisions in the act provide a direct means of controlling the *deposition* of air pollutants or their transformation products.

Provisions were added to the act during its 1977 reauthorization to prevent a State's emissions from causing violations of National Ambient Air Quality Standards in other States or contributing to a pollution problem in other countries (secs. 110(a)(2)(E) and 115, respectively). These provisions are worded very generally and contain no guidelines for determining the sources or effects of transported air pollutants.

Several States have attempted to use these provisions, either through petitions to EPA or litigation in Federal courts, to force other States to curb emissions. To date, few of these suits or petitions have been settled. Recent decisions by Federal courts suggest that they are not prepared to require EPA to give broader consideration to interstate pollution than it does now.

To make the Clean Air Act a more effective means of controlling interstate and international pollution transport, Congress could modify the act in several ways. The changes discussed below would be helpful for addressing many transported air pollution disputes, but would probably be of limited use for such geographically widespread problems as acid deposition.

Options

Option D-1: Amend requirements for considering interstate pollution under the Clean Air Act.

Section 110(a)(2)(E) of the Clean Air Act is a very general provision that offers little guidance on how much interstate pollution is permissible, whether the law applies to the individual sources or to the cumulative sources throughout a State, and how interstate effects are to be demonstrated. Congress could amend the section to clarify EPA responsibilities for assessing and regulating interstate pollution. In addition, Congress could modify procedures for review of interstate pollution petitions (contained in sec. 126 of the act) to allow States to move on to the judicial appeals process if EPA does not act on the petitions before it. Such action would help eliminate the current bottleneck of States' petitions within EPA. Again, such changes would probably not make the Clean Air Act more effective in dealing with *acid deposition,* as the section applies only to pollutants for which National Ambient Air Quality Standards exist. Such changes might, however, assist States seeking relief from transported air pollutants currently regulated under the Clean Air Act.

Option D-2: Amend the international provisions of the Clean Air Act.

Section 115 of the Clean Air Act was designed to address local pollution effects occurring across an international boundary. As with section 110(a)(2)(E), its lack of specificity makes it an unwieldy tool for controlling air pollutants transported over long distances. Congress could amend this section to make it a more effective means of controlling these pollutants, for example, by identifying an appropriate international agency (e.g., the International Joint Commission) or providing a mechanism to establish bilateral commissions to address such problems. Such mechanisms might assist efforts to settle future international air pollution disputes.

NOTE: Copies of the full report "Acid Rain and Transported Air Pollutants: Implications for Public Policy" can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, GPO stock No. 052-003-00956-1.

General Information

Information on the operation of OTA, the nature and status of ongoing assessments, or a list of available publications may be obtained by writing or calling:

Congressional and Public Affairs
Office of Technology Assessment
U.S. Congress
Washington, D.C. 20510
(202) 226-2115

Publications Available

OTA Annual Report.—Details OTA's activities and summarizes reports published during the preceding year.

List of Publications.—Catalogs by subject area all of OTA's published reports with instructions on how to order them.

Press Releases.—Announces publication of reports, staff appointments, and other newsworthy activities.

OTA Brochure.—"What OTA Is, What OTA Does, How OTA Works."

Assessment Activities.—Contains brief descriptions of assessments under way and recently published reports.

Contacts Within OTA

(OTA offices are located at 600 Pennsylvania Avenue, S.E., Washington, D.C.)

Office of the Director	224-3695
Congressional and Public Affairs	224-9241
Energy, Materials, and International Security Division	226-2253
Health and Life Sciences Division	226-2260
Science, Information, and Natural Resources Division	226-2253
Administration Office	224-8712
Personnel Office	224-8713
Publications	224-8996

CONGRESS OF THE UNITED STATES
OFFICE OF TECHNOLOGY ASSESSMENT
WASHINGTON, D.C. 20510

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE. $300

POSTAGE AND FEES PAID
OFFICE OF TECHNOLOGY ASSESSMENT

OTA-O-205

JUNE 1984